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ENSURING SUSTAINABILITY OF ENERGY EFFICIENCY AND ENERGY SECURITY IN DEVELOPING COUNTRIES: A CASE STUDY OF AIRPORTS IN SOUTH AFRICA

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ABSTRACT

Energy efficiency projects that change inefficient lighting technologies to light emitting diode (LED) technology or employ a solar PV plant to lower carbon emissions to bring a certain level of carbon footprint reduction as well as energy security, bring assurance for as long as the lifespan of these technologies. With the passing of time, technologies change and so does legislation, the market, and business focus. Changes in personnel within organisations, governments and even changes in society, culture and way of life is inevitable. To ensure that energy efficiency and energy security are sustained through time this approach must be embedded in employees' everyday lives, independent of specific persons within governments and organisations who advocate for the mitigation of climate change. With the nature of our knowledge of the planet growing all the time, our use of certain technologies and energy sources may be shifted to be aligned to our understanding of what contributes to climate change and other environmental impacts, working with trade-offs to find the most suitable pathway for all affected entities. Our efforts to mitigate climate change cannot be short lived but must constantly evolve to ensure mitigation of climate change. This paper presents principles that provide an approach to ensure that climate change mitigation efforts are sustained through changing technologies, legislation, personnel and markets, and shows the application of these principles in an airport environment.

KEYWORDS: Sustaining Efforts for Climate Change Mitigation, Sustained Reduction in Energy Demand, Sustained Reduction in Carbon emisSions, Energy and Demand Management Strategy, Energy Technology, Energy Legislation, feaSibility Studies, Climate Change Mitigation

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Original Article

INTRODUCTION

Airports Company South Africa (ACSA) over the past eleven years (2010 to present) has been making an effort to reduce carbon emissions across the nine airports it owns and operates in South Africa. The journey began with energy reduction projects being undertaken by the company's electrical and mechanical engineering departments. The efforts to reduce energy consumption was spurred on by the 2008 rolling black-outs and load shedding due to Eskom's lack of electricity capacity to serve the country and the resulting increase in the cost of electricity. Airports were usually prioritised along with medical facilities such as hospitals, but this was on the condition that energy consumption was reduced. As time went on and Eskom's position did not improve, relying on Eskom supply to the airports 24 hours a day, 7 days a week became unsustainable.

The reduction in energy consumption at OR Tambo International Airport (ORTIA) was driven purely by cost savings primarily through a reduction in maximum electricity demand initiatives in collaboration with onsite hotel owners and retail facilities, and lighting upgrades as fluorescent lighting and later LED (light emitting diode)

technology matured in the commercial market. The regional airports, namely, Port Elizabeth International Airport (PEIA), East London (EL) Airport, Bram Fischer International Airport (BFIA), George (GG) Airport, Upington International Airport (UPIA) and Kimberley (KIM) Airport faced a more serious problem of lack of capacity to supply the airport electricity demand as the geographical areas where these airports are were not as developed or urbanised as Johannesburg, Cape Town or Durban. Efforts to reduce energy consumption through replacement of lighting with more efficient matured technology at that time (fluorescent lighting at the regional airports) and the installation of solar PV plants were investigated to make up for the shortfall in energy supply from Eskom. Cape Town International Airport (CTIA) also undertook lighting changes and installed lighting control. King Shaka International Airport (KSIA) being quite new, having been commissioned in May 2010, including new technologies and efficient technologies from the beginning, together with timers for lighting circuits, daylight sensors for outdoor lighting, efficient fluorescent lighting and state of the art air conditioning system with continuous energy saving initiatives being undertaken for its large, centralised air conditioning system. With the cost of a loan to pay off from building the greenfield airport on its monthly debt, it was imperative to reduce cost and reduce energy consumption through energy conservation and energy efficiency which became a key performance indicator that featured on the monthly maintenance and engineering forum made up of maintenance and engineering managers from all the airports with invited electrical or mechanical engineers from the airports spearheading energy reduction projects.

Setting energy reduction targets of 10 % year on year became an unreasonable and unsustainable task especially without the backing of investment and a strategy including a plan of what needed to be done each year to reduce energy consumption enough to meet the target. Certain inconsistencies were also noted where airports that did not attempt any energy saving interventions nevertheless achieved 10 % energy reduction, and those who executed projects to reduce energy consumption observed an increase in energy consumption. This, together with the fact that depending on how the energy reduction target of 10 % year on year was interpreted, by year 10 the airports should consume no energy, highlighted the need for a clear strategy and reasonable, measurable targets that would be achievable based on the investment that management was willing to make. The mechanical engineer who was the representative from KSIA at the maintenance engineering forum (also involved in the commissioning of most of the mechanical engineering infrastructure during the construction stage of the airport) identified this and presented a strategy that was achievable for KSIA, the airport where replacing any new infrastructure to achieve energy savings was not supported by management, due to the airport's completed construction and commissioning in May 2010. KSIA's management team supported the energy management strategy for implementation at KSIA which involved Eskom incentivised lighting replacement for its multi-storey parkade, promotion of energy awareness through a campaign for all its tenants and onsite stakeholders (over 700 participants), and an energy systems optimisation programme undertaken in collaboration with the Industrial Energy Efficiency Project South Africa for its air conditioning and lighting systems, these having been identified as significant energy users. This strategy was supported by KSIA's Chief Aerodrome Engineer at the time and proposed to be adopted for the group of nine airports at the maintenance and engineering forum in 2014.

KSIA's successful energy reduction from 2010 to 2013 and strategy implementation from 2012 [1] resulted in the adoption of an energy management strategy in 2015 for the rest of the airports which proposed an energy management system which mapped out the path for ACSA operated airports to reduce dependency on the grid for their power requirements (power generation). The short term goal was to reduce energy demand (Demand Side Management or DSM) through the implementation of efficient engineering technology systems and optimising processes requiring power with a

view towards creating an ACSA standard which contains energy specifications for all future buildings and infrastructure. Its objectives were to achieve and maintain energy efficiency at all ACSA operated airports in a structured and collective manner by integrating energy efficiency and management into existing maintenance activities and ACSA departmental influencers' decision making, stakeholders, service providers, tenants, retailers and passengers activities to sustain an energy efficient culture, and drafting policies that specified minimum energy requirements for all future buildings and equipment at ACSA operated airports in their path towards compliance with existing global energy standards.

The key mechanical and electrical engineers from the airports formed an Energy Forum led by KSIA's mechanical engineer who proposed the strategy and spearheaded the formulation of the energy reduction projects, commitment to energy reduction targets, drafting of standards and guidelines for energy efficiency and formulation of roadmaps to energy efficiency for all nine airports. Green buildings were quite new in South Africa at that stage, and were investigated, but ACSA was not yet ready for the bold investment commitments to certify infrastructure with green star ratings. When ACSA restructured and implemented a new governance structure and operating model with a new vision, objectives and key performance indicators, "Energy and Demand Management" became formalised within airport structures appointing energy and demand management engineers at the airports and a Chief Energy and Demand Management Engineer role at its corporate office.

With rising electricity prices and the bold vision of ACSA to be leaders in the airport business, there was a need to align energy and demand management efforts to the global context with local relevance. The appointed Chief Energy and Demand Management Engineer (previously the KSIA's mechanical engineer who was instrumental in formulating KSIA's energy management strategy in 2014) led the formulation of the revised energy and demand management strategy which focussed on reducing carbon emissions towards carbon neutrality in electricity consumption.

During the journey of development, progress and awards [1], [2], [3] for efforts of energy reduction, carbon footprint reduction through changing company strategies, personnel, technologies and legislation, there were three key principles that underpinned its sustained success. This paper presents the principles that were used to ensure that energy efficiency and energy security are sustained at ACSA owned and operated airports, which can be used in any developing country.

Principles for Sustaining Energy Efficiency and Energy Security in Developing Countries

Energy affects and is involved in everything we do in life, whether we are at home, at work, at leisure or commuting, regardless of geographical location, political or social structure. Trying to achieve a reduction in carbon emissions to mitigate climate change is ineffective without agreement and support from all parties involved, whether voluntarily or bound by contract, law or business strategy. Most times when energy reduction is achieved due to reduction in costs alone, the trend in Figure 1 is observed.

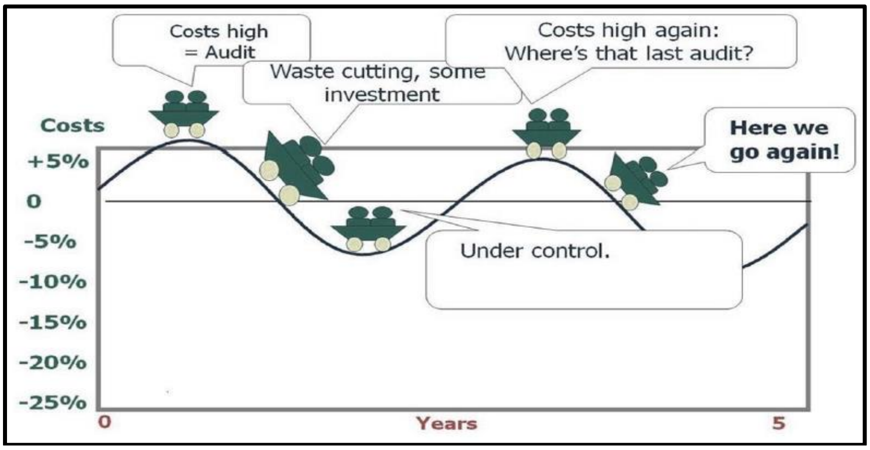

Figure 1: Ad-Hoc Approach to Managing Energy [4].

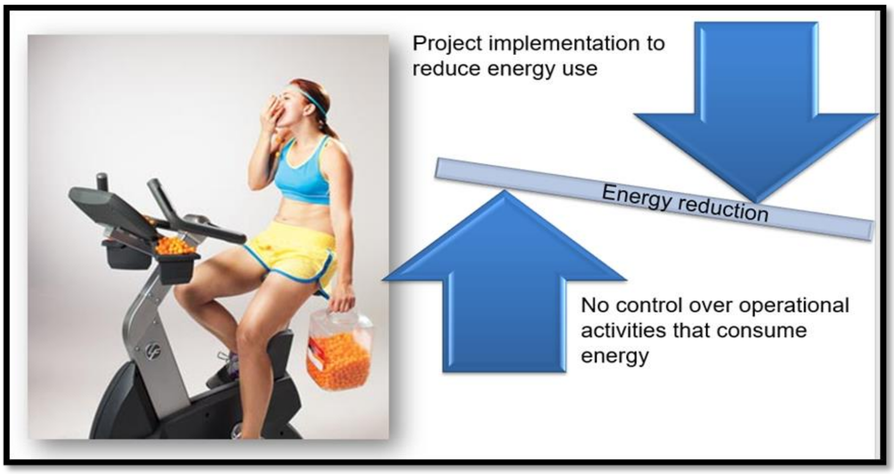

Figure 2: Isolated Attempts to Reduce Energy Consumption.

Without energy efficiency being embedded into everyday activities, there will be no sustained energy decrease, but rather ad hoc projects to reduce energy consumption while inefficient operational activities continue, negating all project efforts that reduce site energy consumption. This is like exercising to lose unwanted kilograms while not controlling one's diet (Figure 2).

While some projects that upgrade technology may have certain operational advantages, making them desirable, without the proper establishment of energy reduction projects in the business process considering the three dimensions of social, environmental and economic integration, most energy reductions projects will fail to gain management support for investment and effort, with other projects taking preference (Fig. 3). This is one of the main reasons why many energy reduction and carbon reduction projects require advocacy, because just a few people believe in it, and it fails to gain traction, becoming unsustainable within the organisation. It usually dies when those who were 'keeping the wheel turning' leave the organisation.

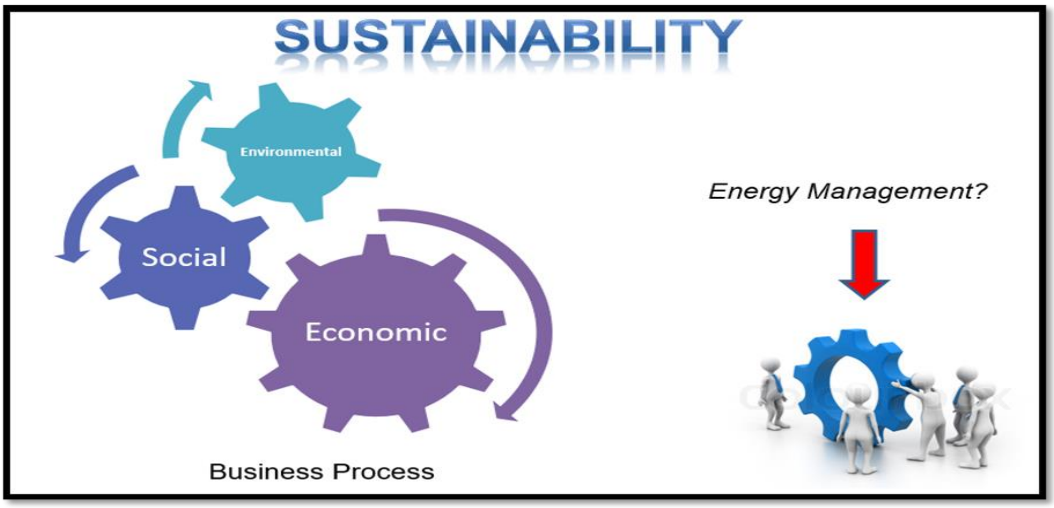

Figure 3: Energy Management Operating outside of the Business Process Poses Sustainability Issues.

Being convinced that climate change is a concern that must be addressed is key to begin the journey of embedding it within the organisations as what people believe filters through to their behaviour, becomes what they practice, and forms part of their culture When they are convinced about pollution and climate change being a real threat to their way of life, they find ways to ensure that awareness is created and this filters into their way of doing business so as to preserve their way of life (Figure 4).

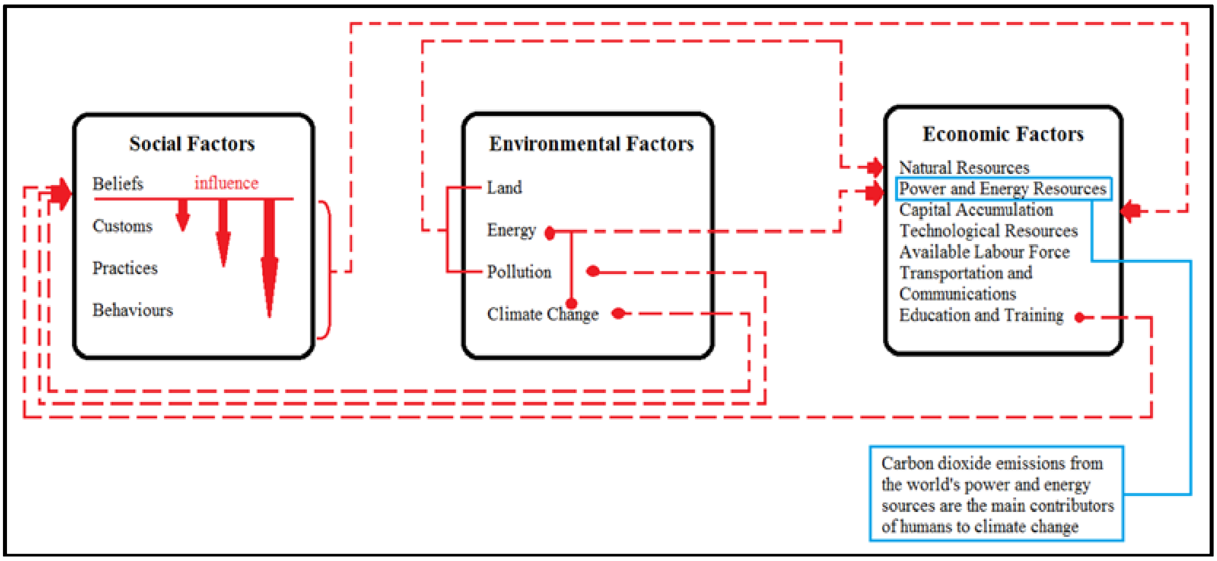

Figure 4: Highlighting the Connectedness of Social Factors to Environmental and Economic Factors.

To ensure the sustainability of efforts to reduce carbon emissions for the continued life of humankind on earth as we know it presently, there are three principles upon which these efforts must be built:

Principle One

Energy efficiency and energy security must form part of an organisation’s strategic plan.

Principle Two

The energy efficiency and energy security strategy must be underpinned by a functional structure that ensures the strategy

is relevant in the global context.

Principle Three

The energy efficiency and energy security strategy must be executed according to the three dimensions of business sustainability, i.e., with social, economic and environmental dimensions becoming part of every business activity and transaction.

These principles will be discussed below, presenting the work that underpinned the success story [1] [2] [3] of ACSA and its nine airports operating in South Africa.

A. Embedding Energy Efficiency and Energy Security in Strategy

While many organisations and countries, if not all, start off with a few energy efficiency and energy conservation projects due to their advantages in lowering costs and optimising operational performance, there comes a point when further efforts to reduce energy consumption are rejected by management due to their priorities being elsewhere, mostly in profitability, and, for state owned organisations, satisfying objectives and commitments made to its shareholders and stakeholders. Reduction in carbon emissions must find its importance and relevance within an organisation's vision, prerogatives and objectives for it to be sustained and become company culture (Figure 5).

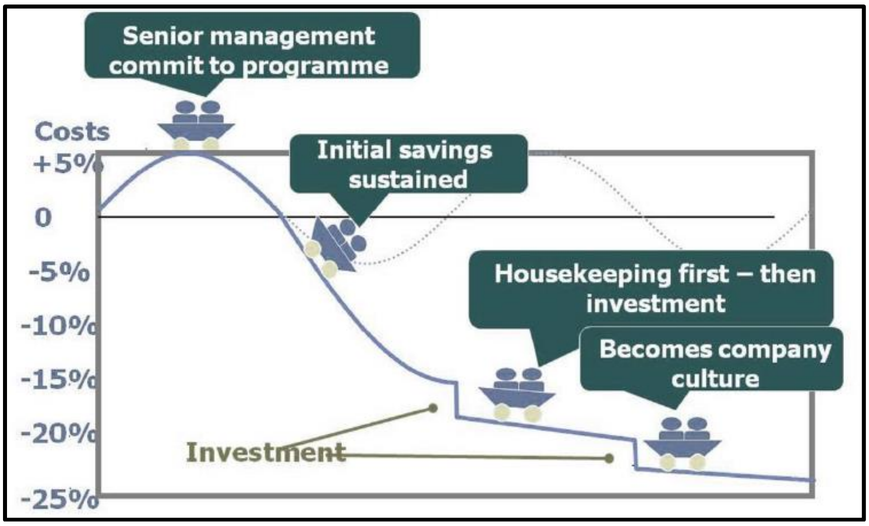

Figure 5: Structured Approach to Managing Energy [4].

The strategy employed must relate to the mitigation of climate change and address the threat faced by the organisation. For a developing country like South Africa, climate change is accelerated through CO_2 emissions by Eskom's coal fired power stations and the threat to the country's off-takers like businesses, organisations, homes, etc. is the risk that energy is not guaranteed for its operations at present and poses great risk into the future. Airport operations thus require a reduction in carbon emissions while securing a reliable source of power that is guaranteed for its future, while remaining profitable. Table 1 shows the energy management strategy proposed and adopted by ACSA for its nine airports in September 2017, after their appointment of a Chief Energy and Demand Management Engineer.

Table 1: ACSA's Energy Management Strategy

Vision: To be a recognised leader in the implementation of energy solutions that are economically and environmentally sustainable to airport businesses. **Aim**: To reach carbon neutrality in electricity consumption by 2030			
Objectives	**Measures of success**	**Initiatives**	**Measures of success**
1. Reduce kWh consumption simultaneously driving carbon neutrality	• Percentage kWh reduction and resulting carbon footprint reduction.	• Develop and implement a carbon neutrality model and track the move towards carbon neutrality • Optimise processes that require energy • Review and update technology constituting baseload energy consumption • Implement energy consumption controls such that energy is consumed only when and where needed	• Develop carbon footprint targets and check progress against targets • Determine engineering equipment process efficiency targets and check progress against targets • Develop baseload energy reduction targets and check progress against targets • Determine energy profile driver targets and check progress against targets
2. Introduce a low carbon energy mix that is responsive to the Airports Company South Africa business and operating environment	• Percentage internal energy mix to grid supplied energy	• Expand solar footprint • Develop and implement an Airports Company South Africa specific energy mix that will not compromise core business objectives	• Develop solar footprint targets and check progress against targets • Develop energy mix targets and compare non-grid supplied energy sources to grid supplied energy sources
3. Drive an energy efficiency culture within Airports Company South Africa that is structured and standardised	• Green Star Accreditation and Airport Carbon Accreditation progress	• Develop and implement department specific energy efficiency targets • Develop and implement a dashboard of energy performance indicators and targets that will assess progress against targets at airport and group level	• Compare energy efficiency progress against energy efficiency targets for each department • Indicate progress on energy performance indicators at airport and group level

Gaining management support for a strategy like the one given in Table 1 is the start of a journey of change that must be managed within the company. It is easier to gain traction if the strategy is co-created and open to adjustments when required for it to be successful in reaching its aim. The strategy in Table 1 was co-created with the energy and demand management forum which has representatives from each airport, and comment and adjustment was invited from implementing managers at the airports before it was submitted to executive management for approval, forming part of board KPIs. The strategy needed to consider greater company objectives and support the organisation's vision. ACSA's vision to be a leader in the airport business required that they position themselves as leaders in the climate change mitigation challenge. The strategy objectives had to be specific, relevant, achievable, timed and its progress measured. To embed this within an organisation is the start of creating a company culture and it starts with the awareness that the current way of doing business needs to change (conviction) (Figure. 6).

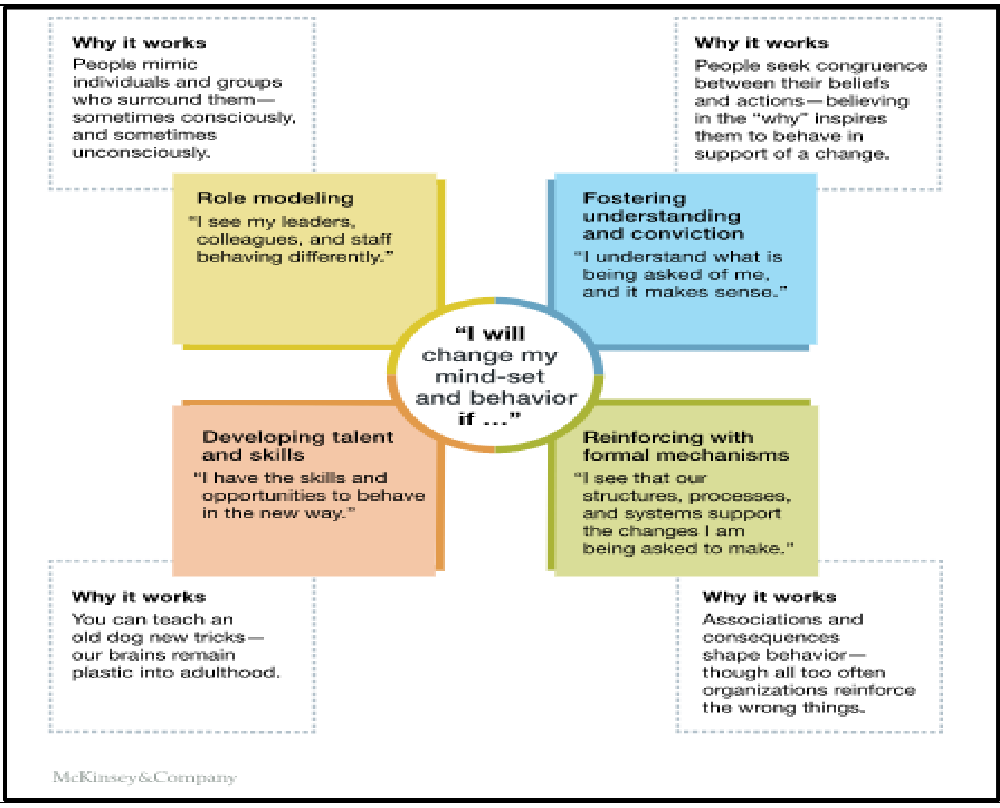

Figure 6: McKinsey & Company Influence Model and Four Building Blocks of Change [5].

Awareness needs to be created in a manner that is relatable to the personnel at various levels within the organisation. When the energy and demand management strategy was approved, the Chief Energy and Demand Management Engineer spent two to three months travelling to the nine airports communicating the strategy to all airport management and maintenance engineering personnel. The method of communication differed. Communication to management took place in boardrooms and follow up was via email with respect to targets and key performance indicators, while communication to maintenance engineering personnel took place in their areas of work, followed by a walk through audit of air conditioning and lighting systems, identification of inefficiencies and need for change in operations and technologies. Energy teams [6] were formed at each airport with roles and responsibilities agreed upon. Formal and informal training followed to ensure that implementation was successful. To achieve carbon neutrality, a suite of technologies was identified for investigation together with the increasing adoption of proven technologies such as LED lighting, lighting control, heat pumps and solar photovoltaic energy. Table 2 gives the identified suite of technologies.

Table 2: List of Technologies to be Investigated for Implementation at Airports to Reach Carbon Neutrality

#	Technology to be Investigated	Notes
1	Natural gas trigeneration [7]	Best suited for ORTIA, CTIA and KSIA due to their large energy baseloads. Utilising waste heat from combustion can be used for water heating requirements and to power absorption chillers.
2	Solar thermal absorption cooling [8]	Could use waste heat or solar thermal energy. When coupled with geothermal heat sinks this is the greenest air conditioning system that possible considering commercially available air conditioning systems. This can be considered for all airports with a centralised air conditioning system.

3	Geothermal energy as a heat sink [9]	Using the ground as a heat sink saves energy and water and can be used as a replacement for any airport with evaporative cooling towers. A trial installation is required.
4	Wind energy using vertical axis wind turbines [10]	Wind turbines and airport communication systems are not always compatible, however, placing vertical axis wind turbines in carefully chosen locations at restricted heights can overcome the barriers to their coexistence. CTIA, PEIA, EL and GG airports are suitable to harvest wind energy.
5	Green star rated facilities [11] [12]	Certifying existing terminal buildings and building all new terminals, offices and retail centres according to 4-, 5- or 6-star green ratings will play a key role in sustaining all efforts to reach and maintain carbon neutrality in electricity.
6	Waste to energy via anaerobic digestion [13]	ORTIA, CTIA and KSIA generate significant volumes of waste that can be used to generate energy.
7	Geyser sleeve technology [8]	Can be adopted for all airports with geysers over 150 litre capacity.
8	Solar thermal deflection innovation [14]	Reduces air conditioning demand.
9	Convective boundaries – low emissivity glazing or double glazing [8]	Reduces air conditioning demand.

As the strategy moved into implementation, targets were included in performance contracts and when company budgets were forecast, the feasible projects were included. This communicated clear expectation and leadership in reducing carbon emissions. Keeping track of progress is key to maintaining traction. Using the plan, do, check, act (PDCA) cycle (Figure. 7) is a good way of ensuring that work is executed, and adjustments made to suit operations.

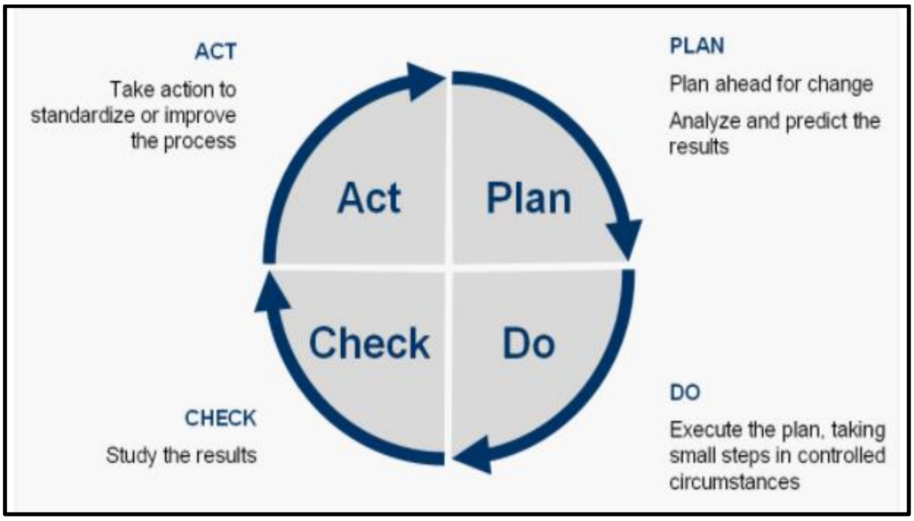

Figure 7: Visualisation of the Plan, do, Check, Act Cycle [15].

Implementation of the projects required to reach carbon neutrality in electricity consumption must be done within a PDCA cycle. The roadmaps to carbon neutrality [16] contain implementable projects that must be executed to reach carbon neutrality, however, there are other activities that must also be considered that do not necessarily involve capital

cost but are equally important in managing energy consumption and influencing decisions that affect the airports' carbon footprint.

Plan

- Annual target to reduce energy consumption including:
- Identify lighting and HVAC operations to reduce energy consumption
- Acquire budgets for projects to be implemented that reduce energy consumption
- Identify and agree on tenant energy reduction activities
- Investigate technologies for implementation of a low carbon energy mix to reduce energy consumption
- Identify technologies applicable to the airport's journey to carbon neutrality
- Gather information necessary for the investigation
- Policies, standards, programmes required to create a culture to reach carbon neutrality
- Plan workshops for standards and guidelines for energy efficiency [17]
- Plan an energy efficiency ambassador programme [17]
- Identify requirements for green leases for tenants [6]
- Identify requirements for service providers service level agreements to align to energy and carbon reduction footprint imperatives
- Standardisation
- Plan workshops for standards and guidelines for solar PV plant installations [18]
- Plans to insource maintenance and operations of solar PV plant installations [18]
- Plan for drafting technical manuals for green buildings (new) [11]
- Plan for drafting technical manuals for transitioning existing buildings into green star buildings [12]
- Catalytic initiatives
- Identify energy and efficiency audits to be done
- Identify training requirements for team members to enable them to operate new technologies and execute operational tasks for reaching carbon neutrality
- Identify management interventions required like ISO 50001 energy management system, energy awareness and communication plans
- Create airport energy teams, finalise roles and responsibilities and finalise terms of reference for the energy and demand management forum

Do

- Execute projects and operational activities to reach the annual energy reduction and carbon reduction targets
- Perform technical and economic investigations on technologies applicable to each airport for their roadmaps to carbon neutrality
- Draft, finalise, agree on, sign and implement tenant lease extracts and service provider service level agreements
- Draft, gain approval, integrate and implement standards and guidelines for energy efficiency, standards and guidelines for solar PV installations
- Draft, finalise and implement guidelines in technical manuals to certify new infrastructure and transition existing terminal buildings towards compliance for a green star rating
- Create and run energy efficiency ambassador programmes
- Draft and agree on phasing of insourcing maintenance and operations of solar PV plants, gain approval and budgets, implement training, acquire necessary certifications and activate skills transfer plans
- Hold environmental awareness campaigns
- Develop and implement communication plan
- Implement requirements for ISO 50001 aligned energy management system
- Perform energy audits
- Train and familiarise technical team members on operations of targeted technologies and efficiency operations of onsite existing technologies
- Execute roles and responsibilities in the airport energy team and energy forum

Check

- Progress on energy reduction and carbon footprint reduction against targets
- Check effectiveness of tenant lease agreement and service level agreement activities in keeping commitments
- Effectiveness of airport energy team and energy forum activities
- Effectiveness of training of team members
- Effectiveness and assess suitability of standards and guidelines
- Effectiveness and applicability of energy ambassador programmes
- Collate learnings of project implementation, ISO 50001 implementation and
- Assess suggestions from awareness campaigns and feedback sessions from the tenants, service providers, energy teams and energy forums

Act

- Adjust as required to improve accuracy in target setting
- Improvement in efforts of tenants and service providers to meet agreed commitments
- Adjust communication plan
- Adjust as per suggestions from awareness campaigns
- Revise standards and guidelines where necessary
- Capture and adjust as per learnings in project implementation
- Adjust energy teams roles, responsibilities, team constitution and energy and demand management forum terms of reference

The energy and demand management forum (Figure. 8) made up of the team leaders of each of the airports' energy teams led by the Chief Energy and Demand Management Engineer undertook tasks that required approval, made strategic decisions in consultation with the airport energy teams, drafted standards and guiding documents, negotiated and agreed on energy reduction and carbon footprint reduction targets. Implementation was carried out at the airports facilitated by the airports' energy teams. The energy teams [6] provided feedback on progress as well as learnings and suggestions for improvement on the effectiveness of the various initiatives to realise the strategy (Figure. 9). Every quarterly meeting included feedback on progress, reporting of barriers and difficulties faced during implementation, and identifying gaps in skills or required training for competence. The quarterly meetings ended with a focussed technical talk on a specific technology or engineering system either for familiarity or for knowledge on efficient and effective maintenance and operations.

Figure 8: Constitution of the Energy and Demand Management Forum.

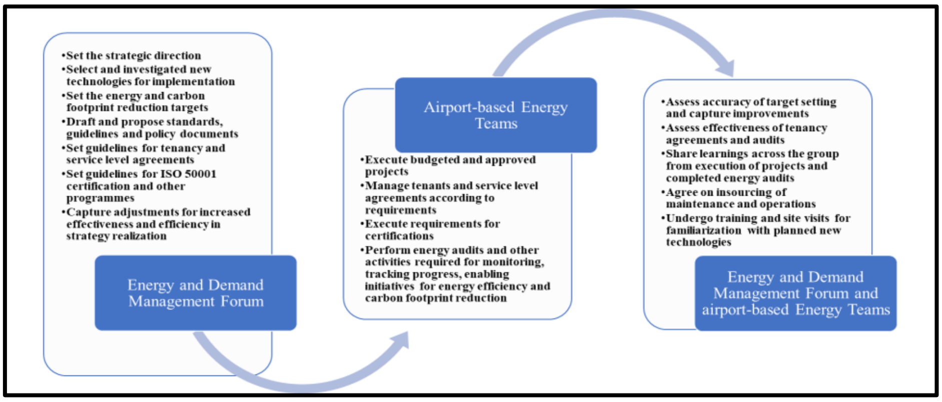

Figure 9: Roles of the Energy and Demand Management Forum and the airport based Energy Teams.

The activities and their details must ensure relevancy to the business and find context within the larger region of South Africa and the rest of the world. The underlying functional structure to ensure that this is done successfully is discussed next.

B. Energy Security and Energy Efficiency Functional Structure

One of the patterns identified at the airports was a heavy reliance on specific persons who were viewed by management and colleagues as having specific knowledge of airport infrastructure and their actions were almost always approved, while others had to go through these individuals to gain support, and little emphasis was placed on the merits of a proposal. As these individuals either retired or left the organisation, certain programmes were halted and this became unacceptable when pursuing a bold vision like being the most sought-after partner in the world for the provision of sustainable airport management solutions.

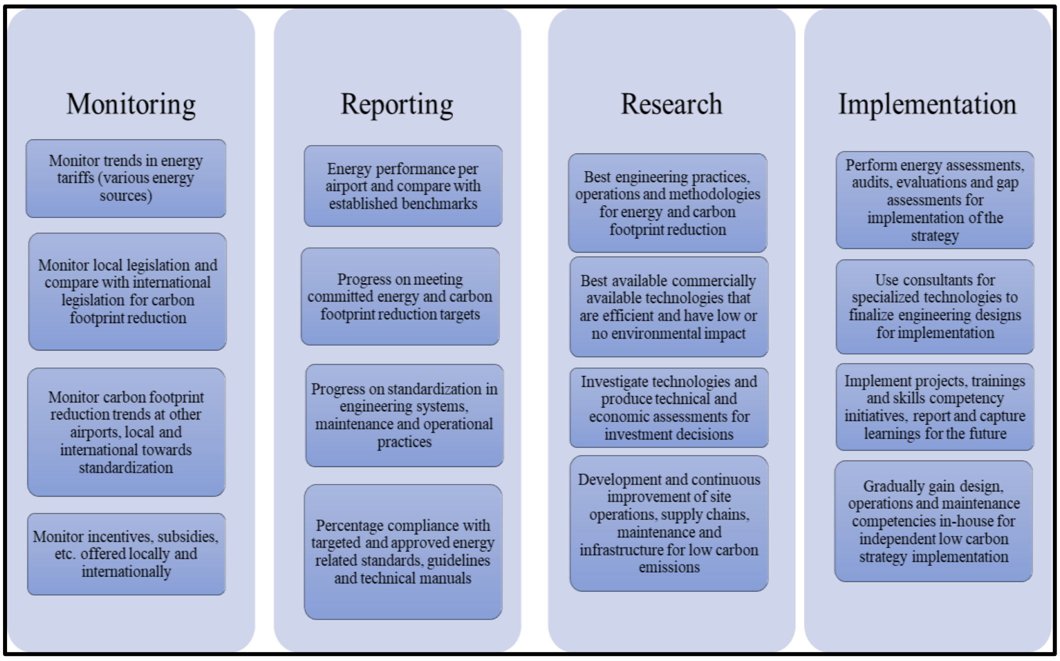

Figure 10: Energy Efficiency and Energy Security Functional Structure.

The activities undertaken to achieve carbon neutrality effectively and sustainably independent of personnel was paramount to the success of realising carbon neutrality. Thus, going back to basic scientific principles that every engineer and technician would be familiar with was the basis to establish robust engineering practices that would be approved and supported by management. These scientific principles formed the basis of engineering policies and became the focus of knowledge sharing in the quarterly technical talks of the energy and demand management forum. Another crucial ingredient for management support is the knowledge of and comparison to international and local benchmarks and assessing where the airports are and where they aim to be based on the approved strategy. Thorough research prior to implementation of alternative energy projects as well as showing the financial value and commercial opportunities of in-sourcing operations and maintenance of specialised group-wide adopted technologies began to change the perception of management and their approval from person-based to merit-based, scientifically proven systems adopted around the world that are proven feasible for the airports. The energy efficiency and energy security functional structure underpinning all activities towards the carbon-neutrality goal is given in Figure 10.

The monitoring function (Figure 10) keeps a “finger on the pulse” of local and international key activities and trends towards reduced carbon emissions. The reporting function shows where the airports are in key aspects of the journey towards energy efficiency and energy security. The research function ensures that all technologies and initiatives towards energy efficiency and energy security are sought out and thoroughly investigated for their benefits, applicability and role in the airports’ journey towards carbon neutrality. The implementation function ensures that whatever has been approved and agreed on is implemented well, learnings captured for continuous improvement with skills and knowledge transfer crucial to daily operations, maintenance and design aspects of technologies and engineering systems.

C. Establish Implementation and Investment for Projects in the Business Process

The business process has social, environmental and economic aspects that, if any initiative is effectively integrated, will be successful. Many times engineering solutions do not go well, however technically brilliant or innovative they are, simply because those who fund and approve such initiatives have not thoroughly bought into it. Technical appreciation is not always the reason that funders and managers support carbon footprint projects. Advantages of alternative energy technologies and technologies that are more efficient must be contextualised through highlighting aspects that are important to funders such as return on investment, and to managers such as increased operational efficiency, the meeting of key performance indicators, decreased operational costs, increasing and building technical capacity, etc.

Many engineers focus on the design of a project, e.g. solar photovoltaic plant, and do not pay attention to how it will be maintained, who will maintain it, where will spare parts be procured from, what happens should the plant fail and downtime exceeds 24 hours, which is often why their projects are not approved.

Another common trap to fall into are ‘greenwashing’ technologies, products, techniques and systems that tend to be prevalent in emerging markets promoted by market players that want to exploit market share. It is important to understand where products come from, how they are made and how certain technological solutions’ implementation will affect the overall site energy consumption, carbon footprint and environmental impact. The environmental impact must be considered more than just from the point of view of reducing energy consumption. Some common trade-offs that are not straight-forward in saving energy is the adoption of skylights in large buildings to reduce the artificial lighting demand as it places additional demand on air conditioning and water heating control which may result in more energy consumed should there be multiple occasions that a water heater is switched off. Another environmental trade-off made is the disposal

requirements of certain lighting technologies which have toxic components. Although solar PV plants are considered to produce clean kWh, their maintenance and disposal may cause a negative environmental footprint. These issues must be addressed and provisions made for them before the investment is decided on. This is how management confidence is gained and maintained. Facing reality about achievements and missed targets is key to long term success as well as making a difference in climate change mitigation.

In developing countries, the lowest cost and quick solutions usually get priority and thus many strategic, long term focuses are neglected due to urgent needs. Carbon footprint reduction has many advantages besides climate change mitigation in developing countries. It has the potential, when done in a manner that entrenches its sustainability, to cause a business to re-examine its goals and efforts towards achieving them. It introduces effectiveness and encourages business integration, causing many departments to follow suit in achieving goals. Financial matters get attention beyond accounting ledgers and into technical transactions, and technical support once being a 'closed box' for engineers becomes common talk among management.

All projects requiring capital should be subject to sound financial investment evaluations that meet the key financial criteria of the organisation. Net present value (NPV), internal rate of return (IRR) and the profitability index (PI) are key criteria for the airports' investment into energy security and energy efficiency technologies. When the NPV is zero or positive is it an investment that pays itself off during its economic lifespan, Equation (1). The IRR is the return (i in Equation (1)) when the NPV is zero. When the IRR is greater than the discount rate (or the weighted average cost of capital - WACC rate), then the investment is feasible for the business. Sometimes the payback period which is the amount of time required for cash inflows generated by a project to offset its initial cash outflow is also given. The payback should be reasonably within the economic lifespan of the investment. The PI (given in Equation (2)) shows the financial attractiveness of the proposed project and is the ratio of the sum of the present value of the future expected cash flows to the initial investment amount. A PI greater than 1.0 is deemed to be a good investment, with higher values corresponding to more attractive projects.

$$NPV = \sum_{t=0}^{T} \frac{R_t}{(1+i)^t} \quad \text{...Equation (1)}$$

Where: R_t = net cash inflows – outflows during a single period t

I = discount rate or return that could be earned

T = number of time periods

$$PI = \frac{PV\ of\ future\ cash\ flows}{Initial\ Investment} \quad \text{Equation (2)}$$

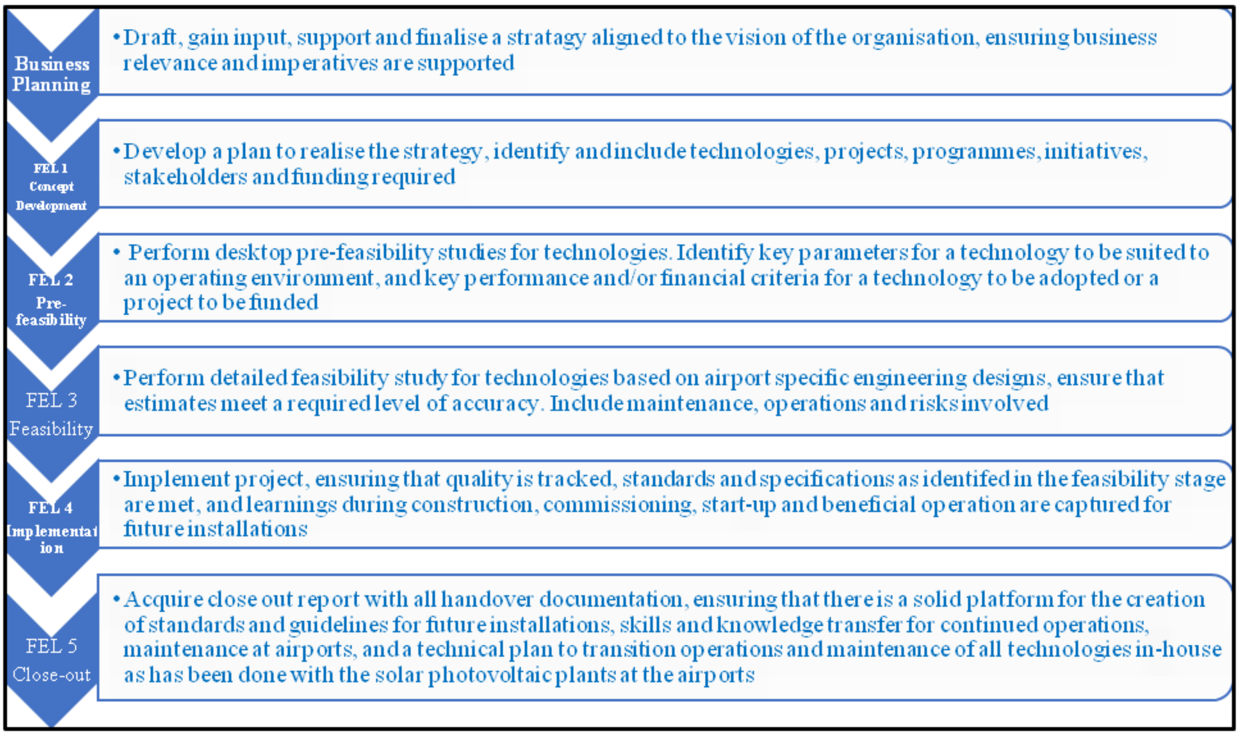

Figure 11: Process for Projects to be Integrated into Business Process.

Financial feasibility follows business planning and concept development stages (Figure. 11). Prior to getting to financial feasibility, projects must be aligned to and be born from the need to realise ACSA's energy management strategy (Table 1). This must be followed by concept development which is instrumental in achieving the goals set out within the strategy. Implementation and close-out must always consider daily operations and maintenance, risks to the business and future cost cutting opportunities and commercial potential.

Business sustainability of new technologies implemented can be ensured by having a logical process to follow that will make the business self-sufficient (Figure. 12).

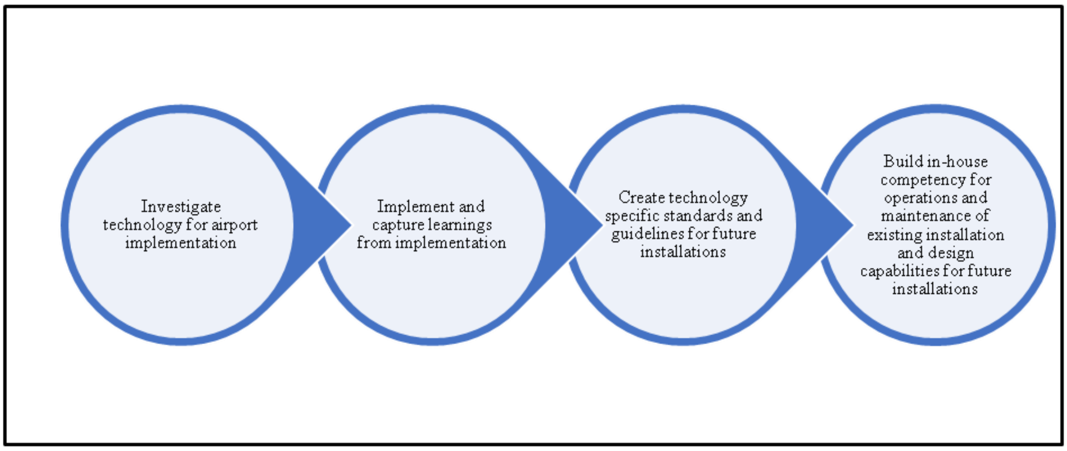

Figure 12: Process for Ensuring Sustainability of New Technologies Introduced into the Business.

Following this process removes the anxiety and 'fear of the unknown' that organisations experience when faced with unfamiliar technologies and their operation and maintenance. It also makes organisations re-assess the way they do business currently with established technologies, highlighting opportunities for improvement and commercial gain. This

approach has the potential to revolutionise the way of doing business and can go as far as restructuring and addressing governance and revenue streams.

CONCLUSIONS

This paper presented three principles to sustain energy efficiency and energy security in a business, presenting the application of the principles in an airport setting. The strategy applicable to ensure energy efficiency and energy security in a business was presented, together with the technologies for realising the strategy, the process for execution of the strategy, the facilitating teams and their coordination for continued progress and improvement. This paper also presented the underpinning functional structure which will ensure that the energy efficiency and energy security activities are relevant to the business and in the global context. The integrating of project activity into the business process encompassing social, environmental and economic aspects, was also given. The application of these three principles reduces the anxiety and removes the unknown involved with adopting new technologies and their operation and maintenance, ensuring that technologies and initiatives are relevant, current and aligned to business imperatives as well as strategy, and that their execution is self-sustaining due to being process dependent.

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